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Delineation of soil available DTPA-manganese status in Tirunelveli district of Tamil Nadu using GIS techniques

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Abstract
A study was undertaken in Tirunelveli district of Tamil Nadu with a view to assess the micronutrient status of soils at block level. A sum of 1,798 geo-referenced surface soil samples from nineteen blocks of Tirunelveli district representing different soil units as per the soil map prepared on 1:50,000 scales were collected randomly at 0-15 cm depth using Global Positioning System. The soil samples were analysed for DTPA- Mn. The content of DTPA- Mn varied from 0.01 to 92.16 mg kg^{-1} soil. Analytical results and the GPS data were used for the preparation of thematic maps showing spatial distribution of micronutrients status block wise in the district. Locations of soil sampling sites of Tirunelveli district were marked on base map on 1: 50,000 scales prepared from State Revenue Maps and digitized using Arc-info GIS. The delineation study thus clearly indicates that, the deficiency status of DTPA –Mn was low to the tune of 15.4 per cents.

Keywords: DTPA –Mn, GPS, GIS, Thematic maps

1. Introduction
Soil micronutrients play a vital role in the growth, development and yield of plant besides the information on the nutritional status of an area and thus go a long way in planning judicious fertilizers and soil management practices to develop economically viable alternatives for farming community. The estimation, characterization and comparison of micronutrients of soil are important issues in site-specific crop management, precision farming and sustainable agriculture (Deb, 1997) [1]. Balanced fertilization, which takes care on all nutrients according to site and crop specific needs to assist the farmer to comply with the demand from the consumer.

In the context of today changing scenario, there is a need to generate the spatial data of micronutrients using frontier technologies like Global Positioning System (GPS) and Geographical Information System (GIS). The GPS has revolutionized positioning concept though it started primarily as a satellite based radio navigation system providing precise, three dimensional position navigation and time information. The GIS provides scientists, planners, managers and decision makers an efficient way of combining and analyzing geo-referenced and descriptive data from different sources (soils, vegetation, geology, land covers and others) for better understanding and management of natural resources (Fernandez *et al*. 1993) [2]. The thematic maps for individual nutrient (Zn, Fe, cu and Mn) is prepared by using GIS software (Minakshi *et al*. 2005; Nayak *et al*, 2006) [4, 5] and multi micronutrient maps are generated by integrating individual maps of Fe, Mn, Zn and Cu in the GIS (Sood *et al*. 2004) [8]. This will also help in monitoring changes in micronutrient status over a period of time. It can be revisited with help of GPS, which is otherwise not possible in the random sampling.

With this background a study was conducted with revolutionary effort to examine soil available manganese status and delineate the available manganese status scrupulously at block level in the Tirunelveli district of Tamil Nadu.

2. Study Area
Tirunelveli district in Tamil Nadu is bounded by Virudhunagar district in the North, Western Ghats in the West, Kanniyakumari district in the South and Thoothukudi district in the East (Fig.1). The Tirunelveli district is comprises of 11 taluks, 19 blocks and 628 Revenue villages covering an area of 6, 81,065 ha of land. The Tirunelveli district lies between 8°.08' and 9°.25' of the Northern latitude and 77°.09' and 77°.59' of Eastern longitude. Major portion of the district is covered by plain topography. Red loam is the predominant soil type in the district accounting for 48.21 per cent followed by the black soil of 30.09 per cent.

2. Material and Methods

2.1 Collection of Soil Samples

Totally 1798 geo-referenced surface soil samples covering the entire village in nineteen blocks of Tirunelveli district were collected randomly at 0-15 cm depth by adopting the standard procedures of soil sample collection. The GPS data (Latitude ºN and Longitude ºE) were collected from each sampling sites distributed over the entire Tirunelveli district by using Garmin GPS 76CS model. The collected soil samples were dried, gently bound, sieved (2 mm sieve) and preserved in polythene bags for DTPA extractable micronutrients (Lindsay and Norvell, 1978) [2].

Locations of soil sampling sites of Tirunelveli district were marked on base map on 1: 50,000 scales prepared from State Revenue Maps and digitized using Arc-info GIS (9.2).

2.2 Generation of Map

The Tirunelveli district map (1:50,000) was map was vectorised by using Raster to Vector software (R2V), and then exported into Arc-GIS software. Database on soil micronutrient status of the study area was developed using Microsoft Excel package. The database was exported to Arc GIS software and the thematic maps on different available micronutrients status were generated. The thematic maps at block level were generated for showing status of different available micronutrients status based on block mean and nutrient index values.

3. Results and Discussion

In Tirunelveli district, the two major soil groups exists are the red and black soils. Red loam is the predominant soil type accounting for 48.21 per cent followed by the black soil of 30.09 per cent. The other types of soils are lateritic soil, sandy coastal alluvium, red sandy soil and others.

3.1 DTPA- Manganese (Table 1)

The content of available manganese varied from 0.01 to 92.16 mg kg^{-1} with an average of 8.00 mg kg^{-1} soil. Considering 2.0 mg kg^{-1} as the critical limit for manganese deficiency as suggested by (Lindsay and Norvell, 1978) [3] the soils of this district had sufficient amounts of available manganese. The Sumai Theerthapuram village of Tenkasi block registered lowest value of 0.01 mg kg^{-1}.

In case of Keelapattam village of Palayamkottai block recorded the highest value of 92.16 mg kg^{-1} which may be due to the high organic carbon content of the soil. This finding confirm with the results reported by Ramesh *et al.* (1994) [6]. The low availability of DTPA-Mn might be due to fixing of manganese cations on the surface of the calcium carbonate particles (Sharma *et al.*, 2003) [3].

3.2 Thematic maps

The DTPA extractable managanese of different blocks of Tirunelveli district was grouped into three categories based on the critical limits followed for availability of micronutrient in India and Tamil Nadu. The thematic map clearly identifies the blocks that are extremely deficient in micronutrient status which require utmost attention to sustain the soil productivity.

In the case of Manganese status, all the blocks had more than 4 mg kg^{-1} (Fig.2) except Radhapuram and Alangulam blocks.

Table 1: Range, Mean values and Percent Sample Category of DTPA-Mn status for different blocks of Tirunelveli district

S. No	Block name	Range and Mean Values	Percentage sample category		
			DTPA- Mn		
		DTPA- Mn (mg kg^{-1})	L	M	H
1	Alangulam	0.25 - 19.77 (3.89)	42.6	23.1	34.3
2	Ambasamudram	1.48 - 15.86 (10.73)	3.4	10.3	86.2
3	Cheranmahadevi	1.28 - 15.09 (9.10)	1.4	12.9	85.7
4	Kadayanallur	2.14 - 20.86 (7.94)	0.0	25.4	74.6
5	Kadayam	0.11 - 12.71 (6.44)	8.0	8.0	84.1
6	Kalakadu	0.28 - 8.68 (4.76)	5.1	30.8	64.1
7	Keelapavoor	1.17 - 25.38 (6.01)	10.6	32.9	56.5
8	Kuruvikulam	3.13 - 17.82 (15.31)	0.0	1.1	98.9
9	Manur	0.24 - 54.10 (8.81)	32.2	36.2	31.6
10	Melaneelithanallur	0.82 - 15.81 (4.37)	39.0	17.0	44.0
11	Nanguneri	0.95 - 58.19 (8.05)	21.6	28.4	50.0
12	Pappakudi	1.94 - 29.90 (10.94)	1.6	12.9	85.5
13	Palayamkottai	1.64 - 92.16 (14.48)	3.9	12.4	83.7
14	Radhapuram	0.06 - 10.63 (2.58)	50.0	36.5	13.5
15	Sankarankovil	0.45 - 22.46 (6.60)	5.2	29.3	65.5
16	Senkottai	0.68 - 12.13 (5.40)	21.3	36.2	42.6
17	Tenkasi	0.01 - 16.31 (8.58)	5.2	15.6	79.2
18	Valliyoor	1.11- 15.78 (5.76)	8.0	42.7	49.3
19	Vasudevanallur	1.0 - 17.31 (4.64)	12.0	44.6	43.5
Over all District			15.4	23.4	61.2

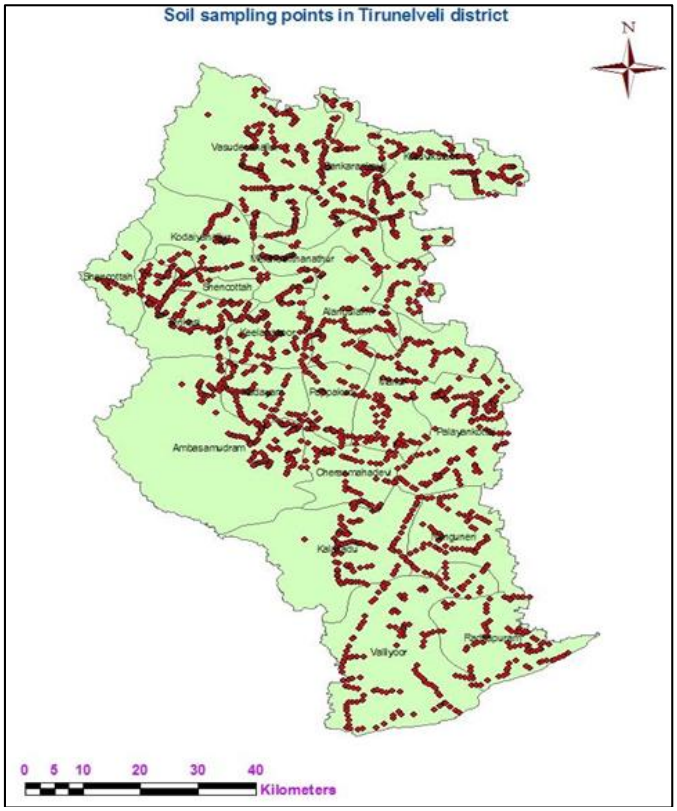

Fig 1: Soil sampling points of Tirunelveli district of Tamil Nadu

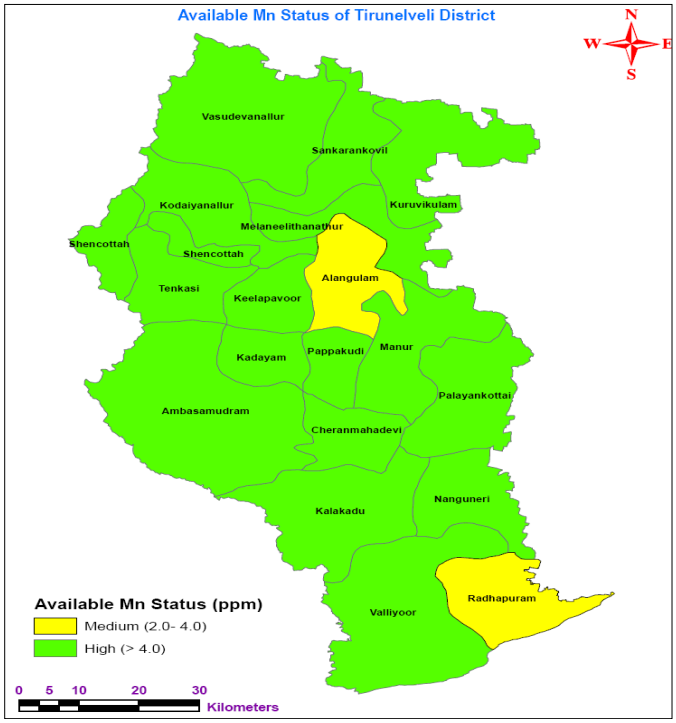

Fig 2: DTPA- Mn status of Tirunelveli District of Tamil Nadu

4. Conclusion

Thus, from the above investigation it is very clear that the soils of Tirunelveli district are sufficient in available manganese and required to be applied in specific situations as per the need. Besides, the edaphic factors such as organic carbon content and free lime status are widely believed to be circumventing the availability of micronutrients, which also needs to be addressed to develop strategies for alleviation of micronutrient deficiencies in Tirunelveli district of Tamil Nadu. Micronutrient status plays a major role in increasing crop yields and soil productivity in general and hence, it is essential to adopt an integrated way of adding organic amendments with micronutrients, which will sustain the soil fertility and crop productivity.

5. References

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